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Preferences for Canned Orange Juices that vary in Brix-Acid Ratio

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MARKETING RESEARCH REPORT NO. 76

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SUMMARY

The purpose of this research was to determine consumers' preferences for six canned orange juices that varied in Brix-acid ratio with the degrees Brix held constant--that is, juices of varying sweetness and relative tartness. This study was undertaken as an aid to improvements in the marketing of canned orange juices.

The Brix-acid ratios tested were 12, 14, 16, 18, 20, and 22; constant at 12° Brix. Increase in Brix-acid ratio brings about a change from relatively tart to relatively sweet in these juices. The universe sampled was all persons 16 years of age and over in Indianapolis, Ind. The sample was composed of 720 households and from 446 to 487 people rated each of the six juices. Each respondent rated a juice for 3 days, and a week later rated a second juice for 3 days. The experimental design was such that throughout the sample every juice was paired with each of the other juices in the 2-week sequence. Certain households, randomly determined, received the same juice for the two tests, without being so informed.

The results revealed three basic preference patterns: (1) People who were favorably disposed to any one of the six juices also were favorably disposed to the others in the set; those who "disliked" any one juice had a similar opinion about the other juices. (2) Within the group of people who were favorably disposed to the set of six juices, relatively high preference was expressed for both the 12 and the 18 Brix-acid ratio juices. Apparently this particular group expects canned orange juice to be either somewhat tart or somewhat sweet and finds certain juices within those regions equally acceptable. (3) Within the group of people who "disliked" the set of juices, two distinct groups emerged -- one giving high preference only to relatively tart juices (12 - 14 Brix-acid ratio) and the other giving its highest preference only to relatively sweet juices (18 - 20 Brix-acid ratio).

These findings suggest that producers of canned orange juice might well market two different kinds of the product -- one at about 12 Brix-acid ratio and the other at about 18 Brix-acid ratio. People who are already disposed to like canned orange juice would find both of these very satisfactory. The relatively tart juice (12 Brix-acid ratio) could be made available for those who presently are not so favorably disposed toward these juices but who do prefer such a juice exclusively. Similarly, the relatively sweet juice (18 Brix-acid ratio) would be available for those within this category who prefer that type of juice exclusively. If such a program of marketing were undertaken, promotion and labeling practices would have to be developed.

In order to satisfy the preference patterns shown, the juices should not vary as much as ± 2 Brix-acid ratio.

The results show that, without being informed as to the manner in which the juices varied, the respondents were reacting to their tart-sweet characteristics. The preference ratings also were reliable indicators of opinion about the juices as ratings given by individuals who tested the same juice on two different occasions were not significantly different.

PREFERENCES FOR CANNED ORANGE JUICES THAT VARY IN BRIX-ACID RATIO [1]

by

James A. Bayton and Hugh P. Bell
Social Science Analysts

INTRODUCTION

In the manufacture of a food product, producers have to decide which particular kind of item, among the possible variations of the item, will be liked best by consumers. Canned orange juice is one of the products about which information is needed on consumer preferences, as a basis for stimulating demand and broadening the market.

It is widely believed that, in addition to the variety of orange, the peel-oil content, and the pulp content, one of the most important factors influencing consumer reactions to processed orange juice is the tart-sweet characteristic of the product. Producers of this product need to know the particular tart-sweet level which has highest preference among consumers. In order to determine this, the research of necessity must be based upon consumer reactions to the various tart-sweet possibilities.

Physical factors in orange juice that determine its tart-sweet characteristics are measurable in terms of degrees Brix and Brix-acid ratio. Degrees Brix is a measure of the specific gravity of a sugar solution. The tart-sweet characteristic of an orange juice is measured by the degrees Brix and Brix-acid ratio. If the specific gravity of a sugar solution is 12.08° Brix and its acidity is 0.81 grams per 100 milliliters, the Brix-acid ratio is 14.9 to 1, computed by dividing 12.08 by 0.81. As the Brix-acid ratio increases at a constant number of degrees Brix, the juices become less tart and increase in sweetness.

The purpose of this research was to determine consumer preferences for six canned orange juices that varied in Brix-acid ratio, with degrees Brix, peel-oil content, and pulp content held constant. Each juice was approximate-

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[1] The research on which this report is based was conducted under authority of the Agricultural Marketing Act of 1946 (RMA, Title II). The Agricultural Marketing Service (Market Development Branch, Market Surveys Section) assumed major responsibility for this research; cooperating were the Florida Citrus Commission and the University of Florida Citrus Experiment Station. The juices used were processed and supplied as a joint enterprise by the two Florida organizations. The field work and tabulation of the data were done under contract by S-D Surveys, Inc.

The authors are indebted to the following persons for their assistance: Forrest E. Clements, former Head of the Market Surveys Section; Shelby A. Robert, Agricultural Marketing Service; Robert W. Olsen, University of Florida Citrus Experiment Station; L. C. McDowell, Florida Citrus Commission; and Carol Cruikshank and Thomas Semon of S-D Surveys, Inc.

ly 12° Brix. The Brix-acid ratio levels were 12, 14, 16, 18, 20, and 22. The lowest Brix-acid ratios were relatively tart; the highest were relatively sweet. Although tarter juices are produced, the particular range tested in this research was recommended by representatives of the Florida Citrus Commission and others in the citrus industry.

In addition to determining preferences for the above juices, interviews were conducted with each homemaker as to her general use of, and attitudes toward fresh, canned, and frozen orange juice.

This research was conducted in Indianapolis, Ind., in November and December 1953.

THE SAMPLE

The Universe sampled was all of the households within the city limits of Indianapolis, Ind. An area probability sample to yield 720 households was drawn. To be eligible each household had to have some type of refrigeration, not necessarily mechanical.

Preference data were obtained from those members of selected households who were 16 years of age and over. Each homemaker -- the person with major responsibility for purchasing and preparing the household's food -- was interviewed concerning the use of fresh, canned, and frozen orange juice. This interview was conducted on the first call to a household.

Of the original 720 households, 695 participated throughout all phases of the research.

EXPERIMENTAL DESIGN

The original 720 households were selected six to a block through 120 blocks. The first week each selected household in a block received one of the six juices. The assignment of the juices to the households was randomly determined. The interviewer left a sufficient supply for each eligible person to be able to drink the juice on 3 successive days. One week after completion of the first test each of the households was given another juice to judge. Each juice was randomly assigned to one-sixth of the households that had a given juice in the first week. For example, 120 households had the 12 Brix-acid ratio juice the first week. Of these, in the second week 20 households received 12 Brix-acid ratio again (without being so informed), 20 received 14 Brix-acid ratio, 20 received 16 Brix-acid ratio, and so forth. In this manner, every possible combination of 2 of the 6 juices occurred in the 2 weeks. Furthermore, for any combination of two juices, for example, 12 and 14 Brix-acid ratio, half of the households involved had the 2-week sequence 12 - 14 and the other half had the 14 - 12 sequence.

The juices were delivered to the households in coded, but unlabeled, 10-ounce cans.

When a juice was delivered to a household, the homemaker was asked to place it in her refrigerator immediately. The tests were to begin the following day and this insured that the juices would be chilled when served for the preference ratings. The supply of juice left was such that fresh cans had to be opened each time the preference ratings were to be given.

In judging the juices the respondents used the scale shown in figure 1. This particular scale was developed through prior research.[2] A juice was rated each day for 3 successive days. Each respondent was asked to make his ratings independent of the other members of the household. The instructions for using the scale were as follows:

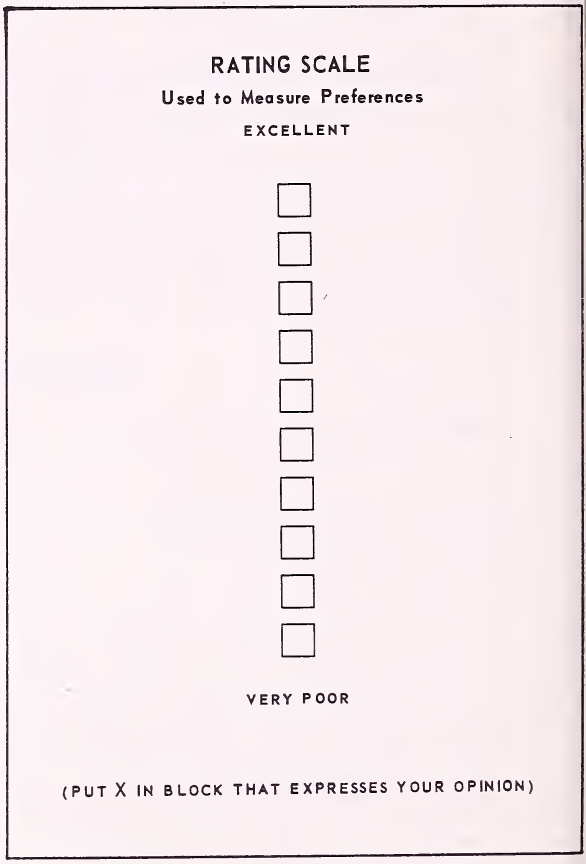
> "From the 'Rating Scale' you will see that your opinion about this juice may be expressed as falling anywhere from 'Very Poor' up through 'Excellent.' Put a cross (X) in the ONE block that expresses your opinion about this juice."

This scale is scored 1 to 10, going from the bottom to the top "blocks." As previously stated, all persons 16 years of age and over in a household gave preference ratings. From 446 to 487 people gave preference ratings for each of the respective six juices.

On the third day of testing a juice the respondents were asked to check those items on a list which they thought best described the juice. The items used were based upon prior research on how people describe these canned orange juices. These items were categorized in terms of sweetness, tartness or sourness, body or consistency, direct comparison with the taste of fresh orange juice, tinniness, and artificiality.

Finally, on the third day of experience with a juice the respondents were asked to answer the following question:

> "If a juice that tastes like this one was on the market, would you like to have it served here in your home?"



RATING SCALE

Used to Measure Preferences

EXCELLENT

☐
☐
☐
☐
☐
☐
☐
☐
☐
☐

VERY POOR

(PUT X IN BLOCK THAT EXPRESSES YOUR OPINION)

Figure 1

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[2] Clements, F. E., Bayton, J. A., and Bell, H. P. Method of Single Stimulus Determinations of Taste Preference. Journal of Applied Psychology, (in press).

In each household the homemaker assumed responsibility for explaining the procedure to the other members and keeping the records for the return visits of the interviewer.

PREFERENCE PATTERNS

Preferences by All Respondents

The mean preference ratings for the six canned orange juices, for all respondents judging a given juice, are shown in figure 2 (table 1, appendix). These data were based upon the mean ratings per individual for the three test days.

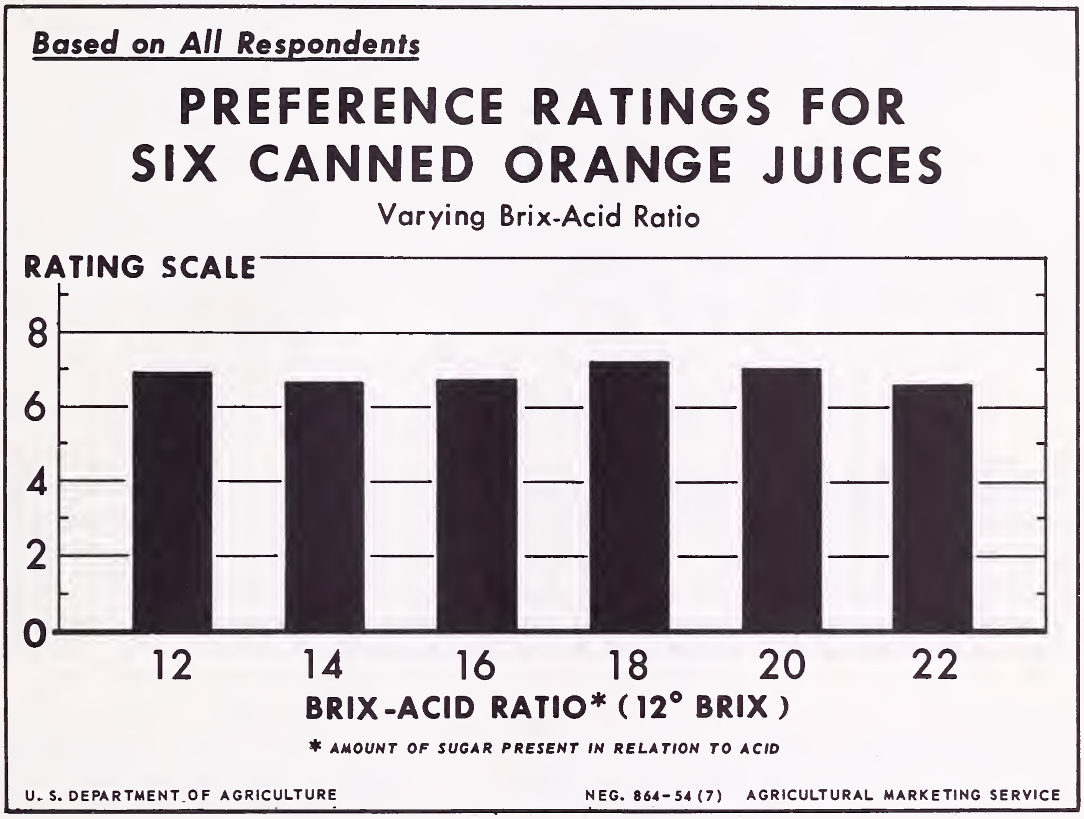

Figure 2

The striking feature of these particular results is the absence of any sharply defined preference pattern, although these canned orange juices varied from relatively tart to relatively sweet. The differences that did occur were of relatively low magnitude. In fact, the difference between the juices with highest and lowest ratings (18 and 22 Brix-acid ratios) was only 0.65 in scale points.

Although the differences between the preference ratings were not marked, there is a slight suggestion that the distribution of preference was bimodal, that is, relatively high preference for these juices tended to be concentrated in two separate and distinct parts of the Brix-acid range. The mean rating for the 12 Brix-acid ratio juice was slightly higher than the mean ratings for the 14 and 16 Brix-acid ratio juices. The mean rating for the 18 Brix-acid ratio juice was a little higher than that for the juice at 12 Brix-acid ratio. The mean ratings for the 20 and 22 Brix-acid ratio juices were somewhat lower than the mean rating for the juice at 18 Brix-acid ratio.

The lack of clear-cut differentiation between these canned orange juices, in terms of preference ratings based upon all respondents, was obtained in a previous, smaller-scale, experiment.[3] In that experiment three juices were tested--12, 16, and 22 Brix-acid ratios, at 12° Brix. When, however, the respondents were divided in terms of whether they "liked" or "disliked" a given juice, a definite pattern did emerge. "Liking" or "disliking" a juice was defined in terms of whether an individual rated the juice above or below the mean for all respondents. Those who "liked" the 12 Brix-acid ratio juice gave the other two juices decidedly lower ratings; those who "disliked" the 12 Brix-acid ratio juice gave the other two juices much higher ratings. Conversely, the respondents who "liked" the 22 Brix-acid ratio juice gave the other juices much lower ratings; those who "disliked" this particular juice gave much higher ratings to the other two juices. These trends exerted a "canceling" effect upon the data based on all respondents, providing a superficial picture of equal degree of preference for the three juices per person. The analysis demonstrated that the mean ratings determined from all respondents were masking definite preference patterns. Because of this prior finding it was decided to analyze the present data in a similar manner.

General "Liking" or "Disliking" of the Juices

The respondents who tested each juice were divided into those who rated it above the mean for all respondents and those who rated it below that mean. The former were designated as the "like" group for the juice in question; the latter as the "dislike" group. Because of the experimental design, within each of these two groups there were subgroups who had tested each of the other juices. The mean ratings given to the other juices by the respective subgroups were determined (tables 2 to 7, appendix).

Inspection of the results of this analysis reveals that, with respect to the entire set of six juices that vary in Brix-acid ratio, the respondents fell into two distinct categories. Those who "liked" a given one of these juices also "liked" the other ones in the set. If a given juice was "disliked" the other juices in the set were "disliked" also.

The mean preference rating for the 12 Brix-acid ratio juice, based upon all respondents who tested that juice, was 6.90. The "like" group gave this juice a mean rating of 8.71. Within this particular group the subgroup which tested the 14 Brix-acid ratio juice gave the latter a mean rating of 8.15. The subgroup with the 16 Brix-acid ratio juice gave it a mean rating of 7.50. Both of these subgroup means were higher than the mean preference ratings for the two respective juices (6.63 and 6.67) as based upon all respondents. This direction of results was observed for the subgroups who tested the 18, 20, and 22 Brix-acid ratio juices. In other words, those respondents who demonstrated that they "liked" the 12 Brix-acid ratio juice, by scoring it above the mean for the entire group, also scored each of the other juices above the means for all respondents who tested these respective juices (tables 1 and 2, appendix). Regardless of the particular juice upon which the initial division into "liking" or "disliking" was made, the subgroups within the "like" category tended to score their respective alternate juices above the means for all respondents (tables 2 to 7, appendix).

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[3] See footnote 2.

The group that "disliked" the 12 Brix-acid ratio gave that juice a mean preference rating of 4.88. (The mean for the entire group was 6.90.) Within this larger group the various subgroups gave their respective alternate juices mean ratings below those given by all of the respondents who rated a given juice (tables 1 and 2, appendix). In this instance, those who "disliked" the 12 Brix-acid ratio juice demonstrated that they "disliked" the other juices, also. Whenever this type of analysis was applied to any one juice this evidence of generally "disliking" the six juices appeared (tables 2 to 7, appendix).

Preference Pattern Within the "Like" Group

It has been shown that a group of people was favorably disposed toward all six of these canned orange juices. Within this group, however, juices were not all equally preferred. Apparently the same individuals showed a preference for separate juices, one a relatively tart juice and the other a sweet juice. This pattern is seen in the preference ratings given by the "like" group for each particular juice -- in each instance, the preference ratings for all juices showed at least two "peaks."

The two-peak nature of the preference pattern is shown quite clearly in the analysis of how the group that "liked" 12 Brix-acid ratio rated the other juices (fig. 3). From 12 through 16 Brix-acid ratio, the preference ratings definitely decreased. At 18 Brix-acid ratio, however, the preference rating became relatively high again. From that point on, the preference declined once more. The respondents who rated the 12 Brix-acid ratio juice relatively high, also rated the 18 Brix-acid ratio juice high.

Inspection of the data for the "like" group for the respective juices shows a pattern similar to that already pointed out. The pattern was not always as sharply defined as that indicated for the group that "liked" 12 Brix-acid ratio, however (figs. 3 to 8). For example, in the case of the group that "liked" 14 Brix-acid ratio, the alternate preference involved two juices--18 and 20 Brix-acid ratio (fig. 4). With the group that "liked" 18 Brix-acid ratio, however, the two-peak preference pattern was a duplicate of the pattern obtained for those who "liked" 12 Brix-acid ratio (figs. 3 and 6).

The individual juices at which the peaks of preference occurred varied with the particular "like" group being analyzed. For example, with the group that "liked" 16 Brix-acid ratio, the peaks were at 16 and 20-22 Brix-acid ratios (fig. 5). Throughout all of these analyses, however, the 18 Brix-acid ratio juice tended to receive consistently high preference ratings. Apparently, within the group of people who "liked" all of these juices, the 18 Brix-acid ratio juice was the favorite. For these same respondents--those

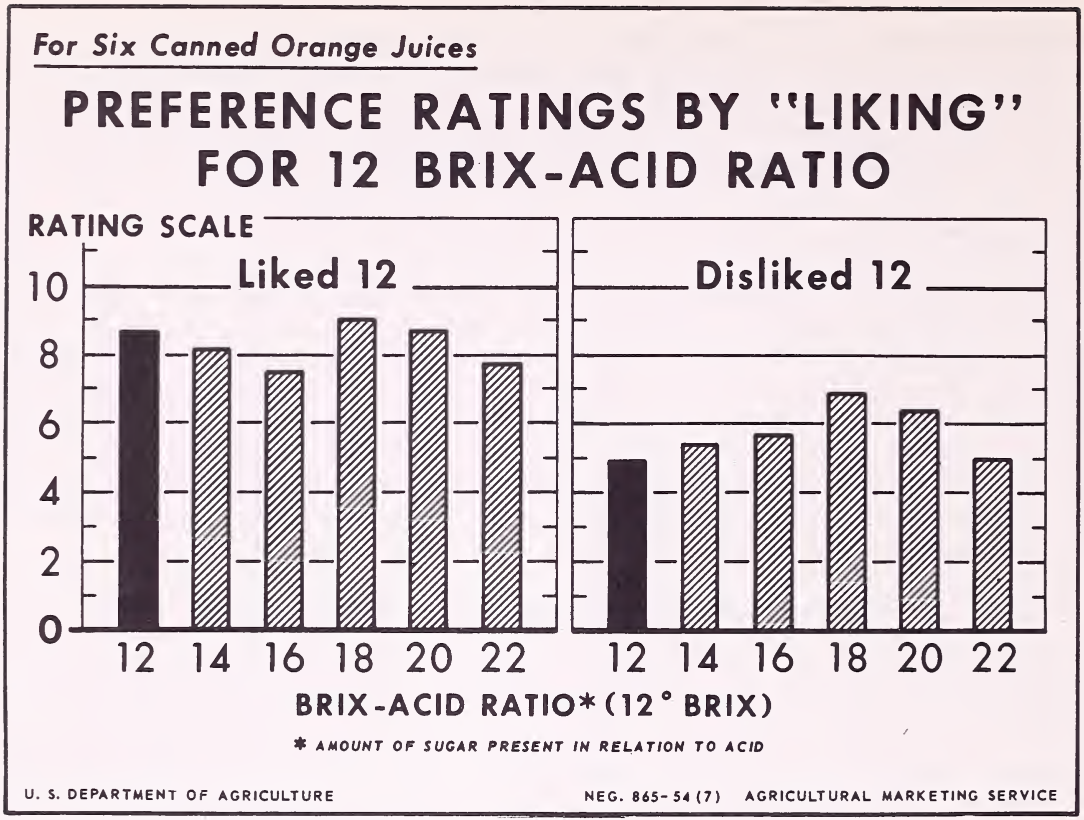

Figure 3

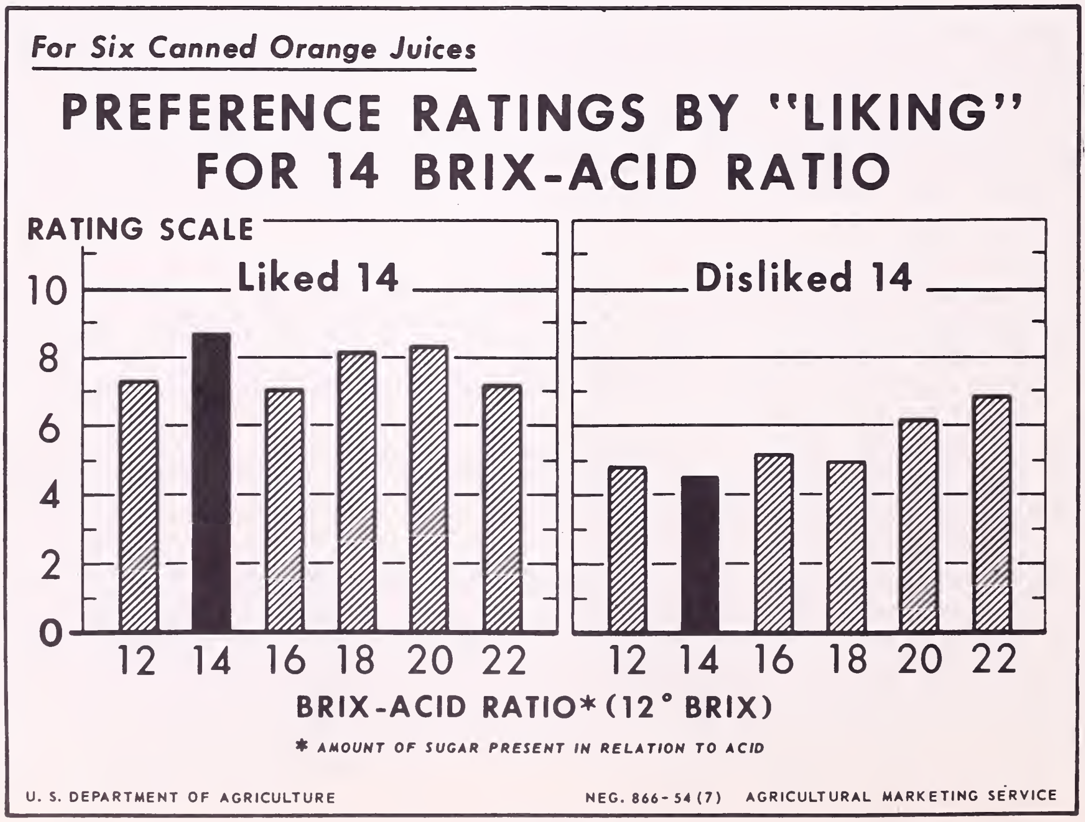

Figure 4

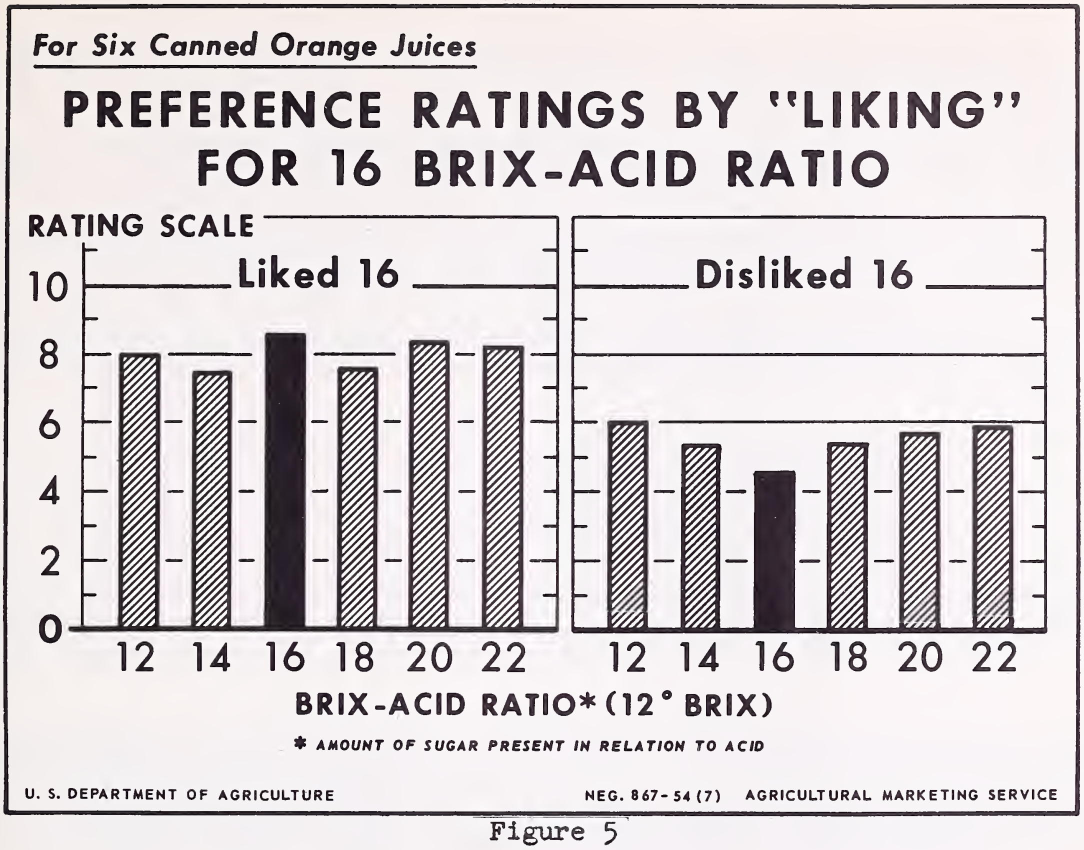

Figure 5

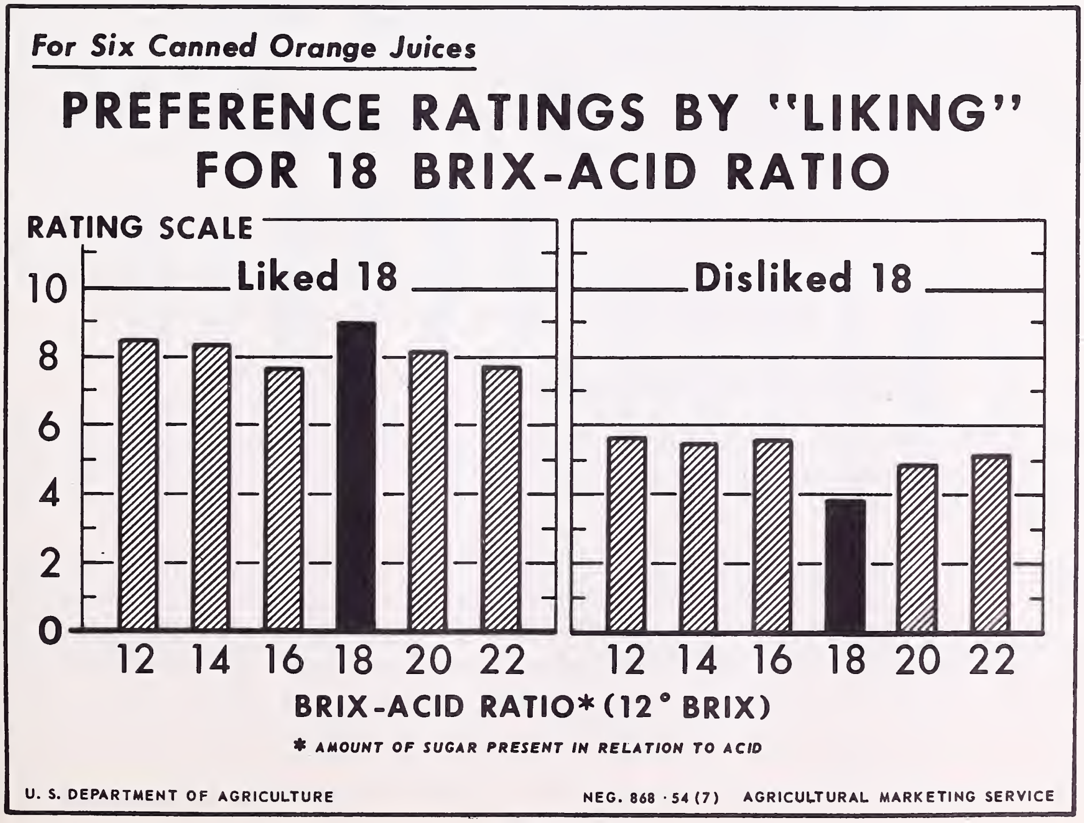

Figure 6

who generally "liked" all juices -- preference was also rather consistently high for the 12 Brix-acid ratio.

These data may be explained in the following manner. Apparently, people who "like" these canned orange juices expect the juices to be either somewhat tart or somewhat sweet. Consistently, they prefer certain juices almost equally. The juice at 12 Brix-acid ratio is the relatively tart juice they prefer, and the juice at 18 Brix-acid ratio is the sweet one.

That relatively high preference within this set of six juices was associated with 12 and 18 Brix-acid ratios is seen in the replies to the following question:

> "If a juice that tastes like this one was
> on the market, would you like to have it
> served here in your home?"

The pattern of the proportions given affirmative replies to this question is also two-peaked in nature (fig. 9). The peaks occur in the relatively tart juices at 12 Brix-acid ratio and in the sweet juices at 18 Brix-acid ratio.

Expressions of willingness to serve the respective juices supported the results obtained in the analysis of preference ratings. For example, in the group that "liked" 12 Brix-acid ratio juice, 83 percent of the respondents said they would like that juice served in their homes. In contrast, only 21 percent of the respondents in the group that "disliked" 12 Brix-acid ratio juice said they would like it served in their homes. Furthermore, the patterns within the "like" and "dislike" groups were duplicated in the replies to the above question. Whereas 83 percent of the group that "liked" 12 Brix-acid ratio said they would like the juice served in their homes, 53 percent of this particular group said they would like the 16 Brix-acid ratio juice served, and 94 percent said they would like the 18 Brix-acid ratio juice served. In the group that "disliked" 12 Brix-acid ratio, the proportion that said they would like a juice served in the home ranged from 21 percent for the 12 Brix-acid ratio juice to 64 percent for the 18 Brix-acid ratio juice and to 23 percent for the 22 Brix-acid ratio juice (compare fig. 3).

Preference Pattern Within the "Dislike" Group

The preference pattern found for those respondents who "disliked" this set of six canned orange juices was quite different from that observed for those who "liked" them.

Among those who specifically "disliked" the 12 Brix-acid ratio juice there was an increase in preference up through the juice at 18 Brix-acid ratio, followed by a decrease in preference for the 20 and 22 Brix-acid ratio juices (fig. 3; table 2, appendix). Those who "disliked" the 14 Brix-acid ratio juice showed an increase in preference through the higher Brix-acid ratio juices (fig. 4; table 3, appendix). The reverse pattern emerged when the analysis was based upon the two juices at the highest Brix-acid ratios. For the group that "disliked" 22 Brix-acid ratio relatively high preference was found in the range from 14 to 18 Brix-acid ratio and a decrease in preference at 12 Brix-acid ratio (fig. 8; table 7, appendix). At 20 Brix-acid ratio the "dislike" group showed a tendency to give increasingly higher preference ratings to the juices at the lower Brix-acid ratios (fig. 7; table 6, appendix).

These data indicate that the general "dislike" group was composed of two quite different groups -- one group preferring a relatively tart juice, the other preferring a relatively sweet juice. This was in direct contrast to the preference pattern within the general "like" group. In that case, the people who scored a relatively tart juice high also scored a sweet juice high.

The fact that within the general "dislike" group some people preferred a relatively tart juice and others preferred a sweet juice was further demonstrated by analysis of the preference patterns for those who "disliked" the 16 Brix-acid ratio juice. In this instance the preference ratings increased at the lower ratios and at the higher ratios. Apparently that juice was satisfactory neither for those who preferred a relatively tart juice nor for those who preferred a relatively sweet juice (fig. 5; table 4, appendix).

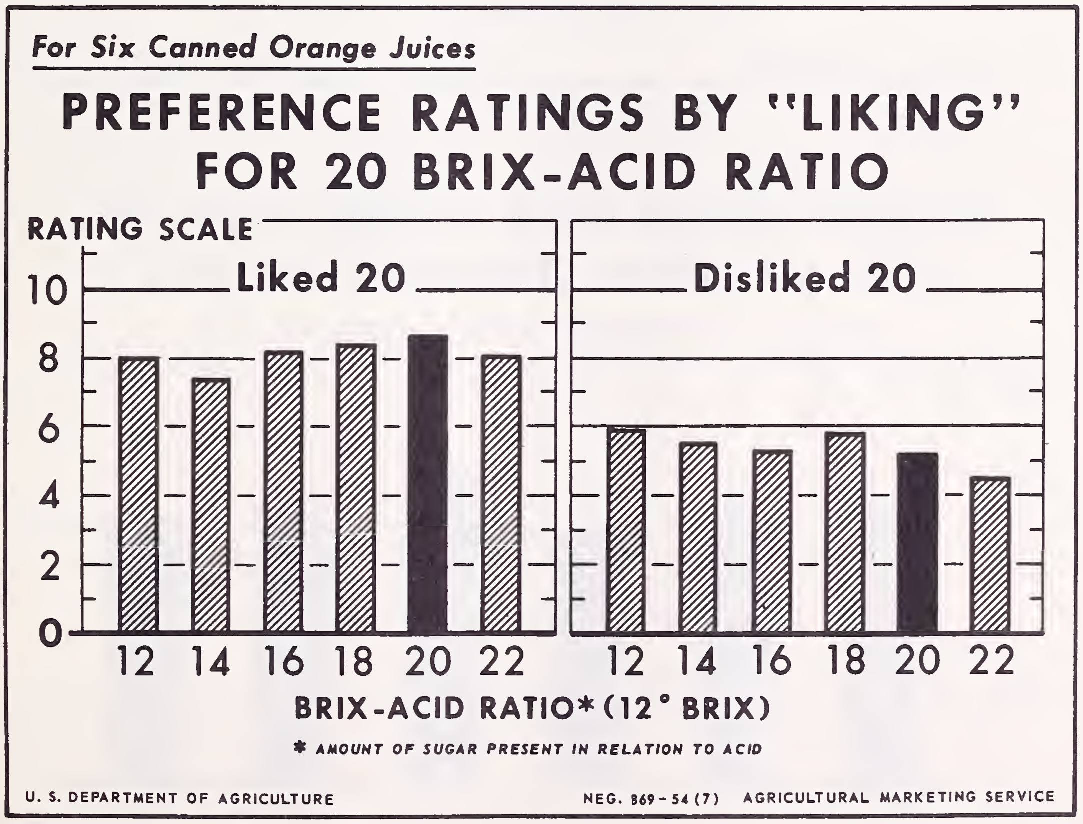

Figure 7

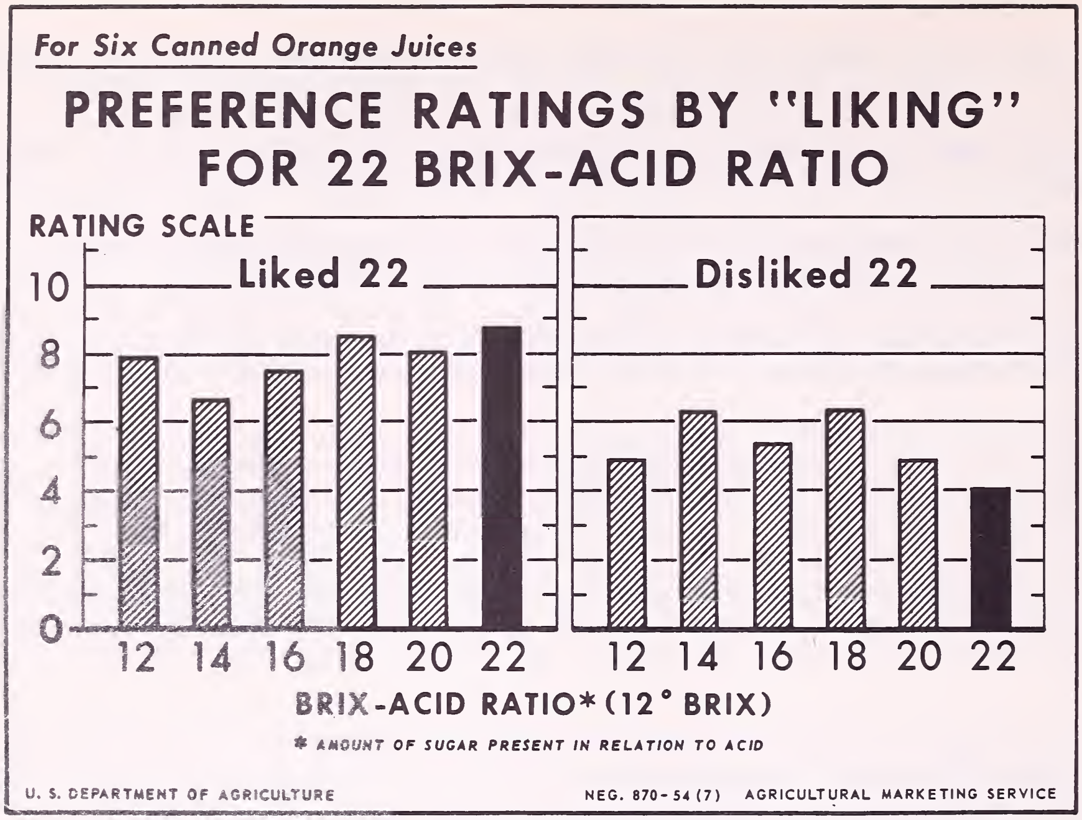

Figure 8

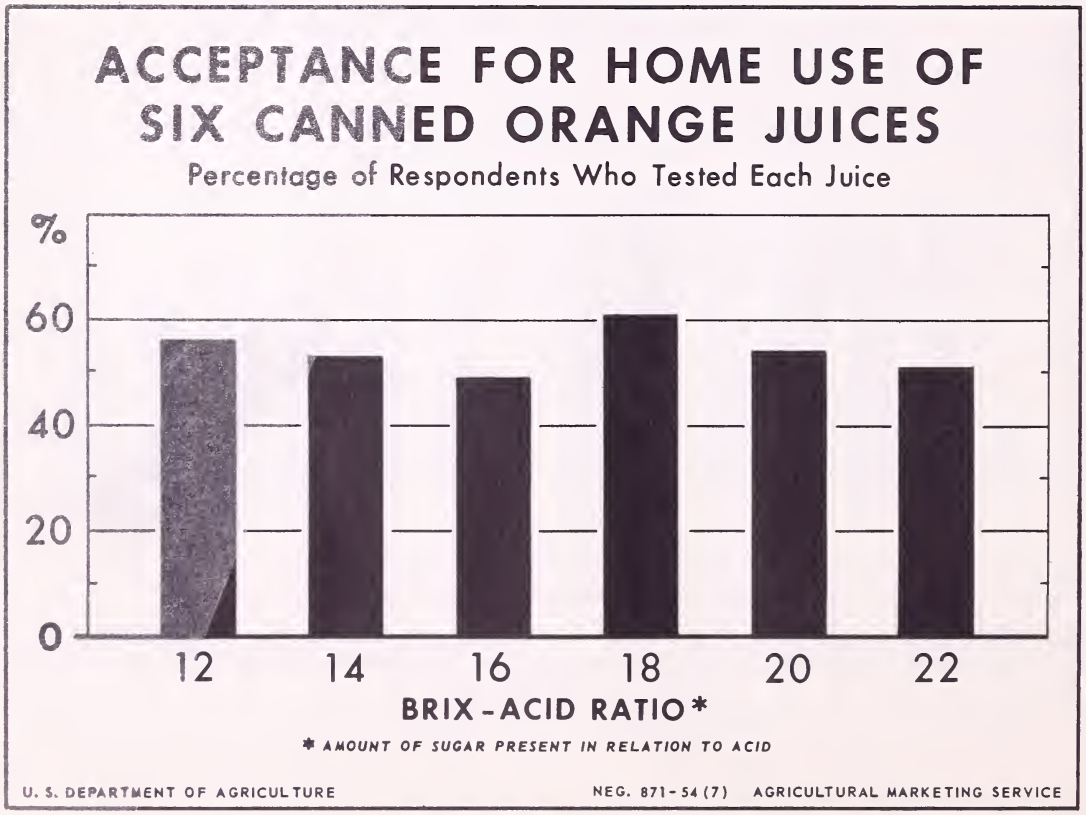

Figure 9

Preference by Age, Sex, and Family Income

The various age groups were not markedly different in the preference ratings for the six juices (table 8, appendix). There was a suggestion that the tartest of the six juices (12 Brix-acid ratio) was preferred by more people 35 years of age and over than by those younger. At 18, 20, and 22 Brix-acid ratios, the younger respondents (16 to 20 years old) tended to give the highest mean preference ratings.

There was no consistent indication of a sex difference with respect to preferences for these canned orange juices (table 9, appendix).

The respondents in the low-income group tended to give each juice a higher preference rating than was true for the respondents in the middle- and high-income groups. Within each income group, however, the pattern of preference tended to be the same -- there was some suggestion of slightly higher preference in the relatively tart juices and in the sweet juices (table 10, appendix).

Implications for Producers

The key problem facing producers of canned orange juice appears to be that a sizable proportion of the population is not favorably disposed to this product, regardless of its Brix-acid ratio (tart-sweet) character. Any efforts to reach these people would involve the marketing of two quite different juices, each designed to meet the requirements of two groups with distinctly different taste preferences. One of these juices would be relatively tart; the other would be relatively sweet. These two segments of the population would have to be informed through promotion that the two kinds of juice were available. Also, the juices would have to be labeled in such a manner that each segment would be able to identify the juice it preferred.

Marketing two such juices would not appear to involve any risk among those people who are favorably disposed to all six of the canned orange juices tested. In fact, within this particular group a relatively tart juice and a sweet juice meet with equally high degrees of preference.

Within the set of six juices used in this research, the two juices which seem to satisfy these requirements would fall at 12 to 14 Brix-acid ratio (relatively tart) and at 18 to 20 Brix-acid ratio (sweet).

VALIDITY OF THE PREFERENCE RESULTS

As stated, these six canned orange juices essentially varied from relatively tart through sweet as the Brix-acid ratio increased from 12 to 22. The respondents were not informed that it was this particular aspect of the juices that was under investigation. An attempt was made, however, to discover whether this variable was, in fact, functioning in the respondents' judgments. That such was the case is seen in the replies to the descriptive checklist each respondent used on the last day of testing a juice.

As the juices increased from 12 through 22 Brix-acid ratio, the proportions of respondents who said the juices were too sweet increased from 5 percent to 13 percent. Over the same range of Brix-acid ratios the proportions characterizing these juices as too tart or sour decreased from 34 percent to 17 percent. Those saying these juices were not tart or sour enough increased from 4 percent to 13 percent. These trends in the use of the above descriptive items were found among those who "liked" the respective juices and those who "disliked" them (tables 11 and 12, appendix).

For all respondents the proportions checking either "just the right sweetness" or "just the right tartness" increased from 12 through 18 Brix-acid ratios and then decreased through 22 Brix-acid ratio (table 11, appendix).

In addition to the tart-sweet qualities of the juices, other factors played a part in the respondents' judgments. Approximately 30 percent of those who tested any one of the given juices said it was too thin or watery, about 20 percent said it tasted artificial, and nearly as many said the juice tasted tinny. As would be expected, such negative characteristics were cited much more frequently by the respective "dislike" than by the "like" groups. About 40 percent of the respondents who had used any one of these juices said that, although it did not taste like fresh orange juice, it still was "pretty good."

RELIABILITY OF THE PREFERENCE RESULTS

In the design of this experiment, 20 of the households which tested a given juice the first week tested that same juice the second week without being informed that they had received identical juices. This feature of the design provided an opportunity to investigate the reliability of the preference ratings. The problem here is whether these ratings were capricious or were stable, reproducible expressions of the respondents' opinions about these juices.

For 5 of the 6 juices the individual preference ratings for the second week were not significantly different from the first week's ratings (table 13, appendix). The one instance of a significant difference per individual was found for the juice at 18 Brix-acid ratio. Although this difference was significant, its magnitude was rather small, 0.26. Apparently, then, the ratings given the juices were reliable indications of respondent opinion about them.

Some evidence of the reliability, or stability, of the preference patterns is to be found in comparing the results of this study with those of previous research.[4] In the prior study only the 12, 16, and 22 Brix-acid ratio juices were used. The set of juices was also 12° Brix. In both studies those who "liked" 12 Brix-acid ratio tended to give lower mean ratings to the 16 and 22 Brix-acid ratio juices than they gave to 12 Brix-acid ratio. Those who "disliked" the 12 Brix-acid ratio juice tended to give the other two juices higher ratings than they gave the 12 ratio juice.

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[4] See footnote 2.

Similarly, the two studies agreed in that those who "liked" the 22 Brix-acid ratio juice tended to give lower ratings to the 12 and 16 Brix-acid ratio juices than to the 22 ratio juice. Those who "disliked" 22 Brix-acid ratio tended to give the other two juices higher ratings than the 22 Brix-acid ratio juice.

DISCRIMINATION BETWEEN BRIX-ACID RATIOS

Once the most preferred item has been determined within a set, the next question is, how far can the product deviate from it without people being able to detect the difference. Knowing the range within which people cannot discriminate permits the producer to establish tolerance levels for his product.

Within the frame work of the design of the present experiment, evidence on ability to discriminate between the juices is to be found in comparisons of the preference ratings given to the pairs of juices tested by each individual. The particular pairs involved are the adjacent juices, in terms of Brix-acid ratio -- 12 vs. 14, 14 vs. 16, and so forth. For each such pairing within the "like" or "dislike" categories, there are two sets of data. For example, one set of data shows how those who "liked" the 12 Brix-acid ratio juice rated 14 Brix-acid ratio; another set shows how those who "liked" 14 Brix-acid ratio rated the 12 Brix-acid ratio juice. If the individuals gave one of the juices in such pairings preference ratings which were significantly different from those given the other juice, one would be foreced to conclude that the two juices were discriminable.

For the 6 juices tested there were 10 sets of pairings of adjacent juices -- 12 vs. 14 Brix-acid ratio, 14 vs. 12 Brix-acid ratio, 14 vs. 16 Brix-acid ratio, 16 vs. 14 Brix-acid ratio, and so forth. In 9 out of 10 instances the individuals who "liked" a given juice gave the adjacent juice a significantly different rating (tables 2 to 7, appendix). Those who "liked" 12 Brix-acid ratio did not give the 14 Brix-acid ratio juice a significantly different preference rating (table 2, appendix). In 5 of the 10 pairings those in the various "dislike" groups gave the adjacent juice a significantly different preference rating (tables 2 to 7, appendix).

These data indicate that people who are favorably disposed toward this set of juices are able to detect differences of the magnitude of 2 points of Brix-acid ratio. Although the data are inconclusive, there is a suggestion that people who are not favorably disposed to these juices do not have this level of discrimination ability.

Previous research on ability to discriminate between canned orange juices that varied in Brix-acid ratio with degrees Brix constant yielded quite different results.[5] In that work, the differences had to be of the magnitude of approximately 5 points of Brix-acid ratio before ability to discriminate was established. Several factors must be taken into consideration in evaluating this inconsistency, however. The earlier results were not based upon a division of the respondents into "like" and "dislike" categories; the juices tested were held constant at either 10° Brix or 14° Brix, rather than the 12° Brix for the current research; and the number of respondents was greater in the present experiment.

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[5] Bell, H. P., and Bayton, J. A. Taste Tests on Canned Orange Juices. Bur. Agr. Econ. June 1953.

More important, perhaps, is the fact that the two experiments utilized two quite different designs. In the prior experiment each person tasted the juices being tested in one brief laboratory session and indicated whether or not he could detect a difference. This judgment was based upon only sips of the juices. In the present experiment each respondent's judgment of a juice was based upon his mean preference rating after 3 days of drinking a juice in his home. He did not have to make direct comparisons between juices at a given time. In this procedure, discrimination ability was inferred from the preference ratings.

The first procedure draws upon the psycholphysical "method of comparative judgments," in which the particular category of psychophysical reaction being studied is investigated by having the respondent evaluate the items comparatively in one experimental session. In the present experiment the "method of single stimulus" was used, with the respondent making the called-for evaluation while working with one item at a time in isolated sessions.

Variations of the method of comparative judgment (paired comparisons and rank order procedures) have been used to determine taste preferences. Whenever such procedures are to be used prior discrimination testing, of a comparative judgment type, is apparently necessary in order to insure that the person is being asked to judge items that he readily recognizes as being different when he tastes them one right after the other. The particular approach used in the present research is, however, more realistic in that it was based upon a natural, home situation. It is doubtful, furthermore, whether an individual has many opportunities to make direct comparisons at any one time of alternative food products such as these juices.

The procedure used in this experiment could be misleading sometimes, however, when used to infer discrimination ability. It will be recalled that within the general "like" group, preference tended to be "two-peaked" at about 12 and 18 Brix-acid ratios. The individuals in the group that "liked" 12 Brix-acid ratio who also tested the 18 Brix-acid ratio juice did not rate the latter significantly different from their judgment of the 12 Brix-acid ratio juice (table 2, appendix). On the surface this apparently indicates that these respondents could not discriminate between the two juices. Actually, the other evidence indicates that the two juices were discriminable -- one being relatively tart and the other relatively sweet to the respondents -- but were similar in degree of preference.

In summary, the inferences from the preference results as to discrimination ability lead to the conclusion that if producers decide to market two canned orange juices, at 12 and 18 Brix-acid ratios, maintenance of quality would necessitate keeping the product within tolerance limits of ± 2 Brix-acid ratio points for each type. For example, for the 18 Brix-acid ratio juice, the Brix-acid ratio should neither drop to 16 nor rise to 20 (table 5, appendix).

INTERVIEWS WITH HOMEMAKERS

Use of Fresh, Frozen Concentrated, and Canned Orange Juices

In Indianapolis, practically all homemakers had used some form of orange juice within the last year. Seventy percent of the homemakers had used frozen concentrated orange juice, 68 percent had used fresh orange juice, and 62 percent had used canned orange juice (table 14, appendix). The proportions of homemakers using fresh orange juice or frozen concentrated orange juice tended to increase with family income. This relationship was most marked for frozen concentrated orange juice. In contrast, the proportion of homemakers in the upper income group who used canned orange juice was less than the proportions reporting this in the lower and middle income group (table 15, appendix).

Seventy percent of the users of frozen concentrated orange juice and 77 percent of those who used canned orange juice said they used about the same amount of these products throughout the year. For those who reported a seasonal distinction in use, fresh oranges received greater use in the winter and both frozen concentrated orange juice and canned orange juice had greater use during the summer. For each of the latter two products, only 8 percent of the homemakers said they made their greatest use of them during the winter months (table 16, appendix).

Approximately 8 of each 10 homemakers who used a given one of the three products said that, during the period of greatest use, the juice was served several times a week (table 17, appendix). Among those who used a product, frequency of use, during the period of greatest use, was not related to family income (table 18, appendix).

Reasons Given for Infrequent Use or Nonuse of Fresh Orange Juice

The key reasons given for either infrequent use (less than several times a week) or nonuse of fresh orange juice were the same, although the proportions of homemakers citing them differed. Reasons such as "I seldom think of it" were given by nearly half of the infrequent users of fresh orange juice; nearly 20 percent of the nonusers of this product gave reasons such as "I never think of it." Approximately 35 percent of the infrequent users said they found fresh orange juice inconvenient and difficult to prepare. Seventy percent of the nonusers of fresh orange juice gave those reasons. Slightly less than 10 percent of the infrequent users and nonusers of fresh orange juice, respectively, cited cost reasons (tables 19 and 20, appendix).

Reasons Given for Infrequent Use or Nonuse of Frozen Concentrated Orange Juice

Among infrequent users and nonusers of frozen concentrated orange juice, about half of the respective homemakers accounted for this by giving reasons such as "I seldom (never) think about it." Twenty percent of the infrequent users said this was due to the cost of the product; 12 percent of the nonusers gave this particular reason. Neither taste nor health reasons seemed prominent among infrequent users and nonusers of frozen concentrated orange juice (tables 19 and 20, appendix).

Reasons Given for Infrequent Use or Nonuse of Canned Orange Juice

Fifty-five percent of the infrequent users and 24 percent of the nonusers of canned orange juice gave as their reasons for this the fact that they seldom or never thought of the product. Most of the other reasons given had to do with the taste of canned orange juice -- "tastes artificial," "too thin or watery," "its tinny or metallic," "too bitter" (tables 19 and 20, appendix).

APPENDIX

Table 1.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix)

Mean and standard deviation	Brix-acid ratio					
	12	14	16	18	20	22
Mean ----------------------	6.90	6.63	6.67	7.21	7.01	6.56
Standard deviation ---------	2.56	2.63	2.63	2.54	2.60	2.70
Number of people -----------	446	467	462	462	473	487

Table 2.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 12 Brix-acid ratio [1]

"Like" - "Dislike" 12 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 12 Brix-acid ratio						
Mean --------------------	8.77	8.15	7.50	9.04	8.69	7.76
Standard deviation ------	0.99	1.93	1.89	1.44	1.36	1.82
t [2] --------------------	--	1.54	4.99	0.44	0.78	4.16
Number of people -----------	224	32	47	54	49	42
"Dislike" 12 Brix-acid ratio						
Mean --------------------	4.88	5.38	5.63	6.81	6.34	4.91
Standard deviation ------	1.29	2.56	2.54	1.98	2.09	2.70
t [2] --------------------	--	2.95	3.52	4.47	3.56	2.03
Number of people -----------	174	47	28	25	35	39

[1] "Like" group rated 12 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 12 Brix-acid ratio below the mean for all respondents.

[2] Based on mean of individual differences from rating of 12 Brix-acid ratio.

Table 3.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 14 Brix-acid ratio 1/

"Like" - "Dislike" 14 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 14 Brix-acid ratio						
Mean	7.33	8.74	7.05	8.20	8.33	7.18
Standard deviation	1.99	1.15	2.79	2.10	1.77	2.13
t 2/	4.67	--	3.53	2.24	0.72	4.07
Number of people	43	217	37	51	45	41
"Dislike" 14 Brix-acid ratio						
Mean	4.80	4.53	5.12	4.91	6.17	6.86
Standard deviation	2.85	1.45	2.67	2.51	2.25	2.39
t 2/	1.85	--	1.75	2.35	3.51	4.54
Number of people	36	188	46	25	44	37

1/ "Like" group rated 14 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 14 Brix-acid ratio below the mean for all respondents.

2/ Based on mean of individual differences from rating of 14 Brix-acid ratio.

Table 4.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 16 Brix-acid ratio 1/

"Like" - "Dislike" 16 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 16 Brix-acid ratio						
Mean	7.94	7.42	8.56	7.55	8.39	8.16
Standard deviation	2.15	2.18	1.08	1.64	2.36	2.46
t 2/	1.74	3.68	--	2.58	0.51	2.86
Number of people	41	36	222	48	50	47
"Dislike 16 Brix-acid ratio						
Mean	6.04	5.41	4.61	5.42	5.67	5.82
Standard deviation	2.73	2.22	1.32	2.71	2.51	2.28
t 2/	4.11	5.20	--	3.03	2.55	5.30
Number of people	34	47	185	27	35	42

1/ "Like" group rated 16 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 16 Brix-acid ratio below the mean for all respondents.

2/ Based on mean of individual differences from rating of 16 Brix-acid ratio.

Table 5.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 18 Brix-acid ratio 1/

"Like" - "Dislike" 18 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 18 Brix-acid ratio						
Mean	8.46	8.32	7.64	9.06	8.18	7.72
Standard deviation	1.94	2.27	1.71	0.81	2.09	2.59
t 2/	3.68	2.63	3.49	--	2.48	2.21
Number of people	58	44	37	255	47	69
"Dislike" 18 Brix-acid ratio						
Mean	5.63	5.47	5.56	3.90	4.86	5.13
Standard deviation	2.52	2.56	2.59	1.78	2.53	2.06
t 2/	0.26	2.30	1.75	--	0.13	0.47
Number of people	21	32	38	165	39	35

1/ "Like" group rated 18 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 18 Brix-acid ratio below the mean for all respondents.

2/ Based on mean of individual differences from rating of 18 Brix-acid ratio.

Table 6.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 20 Brix-acid ratio 1/

"Like" - "Dislike" 20 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 20 Brix-acid ratio						
Mean	7.98	7.33	8.16	8.35	8.62	8.07
Standard deviation	2.23	2.41	1.71	1.83	0.92	2.39
t 2/	3.86	5.18	5.57	2.64	--	2.27
Number of people	51	54	50	43	233	35
"Dislike" 20 Brix-acid ratio						
Mean	5.84	5.51	5.29	5.78	5.18	4.54
Standard deviation	2.06	2.12	1.73	2.29	1.29	2.49
t 2/	1.01	1.65	2.30	4.29	--	0.72
Number of people	33	35	35	43	189	43

1/ "Like" group rated 20 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 20 Brix-acid ratio below the mean for all respondents.

2/ Based on mean of individual differences from rating of 20 Brix-acid ratio.

Table 7.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" 22 Brix-acid ratio [1]

"Like" - "Dislike" 22 Brix-acid ratio	Brix-acid ratio					
	12	14	16	18	20	22
"Like" 22 Brix-acid ratio						
Mean	7.96	6.61	7.47	8.51	8.02	8.75
Standard deviation	1.70	2.74	2.79	1.73	1.86	1.21
t [2]	1.49	4.27	4.63	0.89	2.89	--
Number of people	43	45	55	41	39	223
"Dislike" 22 Brix-acid ratio						
Mean	4.83	6.20	5.33	6.23	4.80	4.02
Standard deviation	2.68	2.50	2.95	2.37	2.74	1.52
t [2]	2.35	3.89	2.30	2.63	3.12	--
Number of people	38	33	34	63	39	207

[1] "Like" group rated 22 Brix-acid ratio above the mean for all respondents. "Dislike" group rated 22 Brix-acid ratio below the mean for all respondents.

[2] Based on mean of individual differences from rating of 22 Brix-acid ratio.

Table 8.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by age of respondent

Brix-acid ratio	Age of respondent								
	16 - 20 years			21 - 31 years			35 years and over		
	Mean	Standard deviation	Number of people	Mean	Standard deviation	Number of people	Mean	Standard deviation	Number of people
12	6.65	2.24	22	6.36	2.68	170	7.29	2.44	254
14	6.29	2.60	35	6.78	2.43	169	6.65	2.69	256
16	6.56	2.77	42	6.48	2.37	151	6.81	2.72	268
18	7.40	2.20	27	7.19	2.48	167	7.21	2.56	260
20	7.22	2.70	33	7.15	2.25	188	6.87	2.82	250
22	6.78	2.55	39	6.51	2.75	168	6.57	2.68	272

Table 9.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by sex of respondents

Brix-acid ratio	Sex of respondents					
	Male			Female		
	Mean	Standard deviation	Number of people	Mean	Standard deviation	Number of people
12	6.88	2.68	195	6.92	2.47	251
14	6.70	2.58	202	6.57	2.66	265
16	6.78	2.58	202	6.58	2.66	260
18	7.17	2.46	201	7.24	2.60	261
20	6.94	2.61	226	7.08	2.59	247
22	6.60	2.74	216	6.53	2.66	271

Table 10.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by family income

Brix-acid ratio	Family income								
	Low (Less than $4,101)			Middle ($4,101 to $6,413)			High (Over $6,413)		
	Mean	Standard deviation	Number of people	Mean	Standard deviation	Number of people	Mean	Standard deviation	Number of people
12	7.14	2.75	112	6.94	1.99	106	6.39	2.55	132
14	6.98	2.74	125	6.77	2.38	138	6.23	2.30	120
16	6.84	2.82	124	6.43	2.64	114	6.42	2.54	173
18	7.71	2.40	107	6.70	2.44	106	7.25	2.26	166
20	7.22	2.57	104	7.16	2.10	118	6.33	2.88	149
22	6.82	2.61	105	6.65	2.35	141	6.13	2.78	149

Table 11.--Respondents' descriptions of six canned orange juices that vary in Brix-acid ratio (12° Brix)

Description	Brix-acid ratio					
	12	14	16	18	20	22
	Percent [1]	Percent [1]	Percent [1]	Percent [1]	Percent [1]	Percent [1]
Just the right sweetness	49	56	54	65	63	58
Not sweet enough	8	6	6	8	4	4
Too sweet	5	5	8	6	11	13
Just the right tartness	49	49	49	64	54	51
Too tart or sour	34	29	30	16	17	17
Not tart or sour enough	4	6	9	6	13	13
Just the right body or consistency	59	59	61	62	62	56
Too thin or watery	30	31	30	25	32	37
Too thick	4	2	2	1	1	1
Does not taste like fresh orange juice, but still pretty good	43	43	41	45	41	41
Tastes like fresh orange juice	22	19	18	23	25	19
Tastes artificial	21	22	23	17	22	23
Tastes tinny	16	15	21	19	13	18
Number of people	446	467	462	462	473	487

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[1] Percentages add to more than 100 because some respondents checked more than one descriptive item.

Table 12.--Respondents' descriptions of six canned orange juices that vary in Brix-acid ratio (12° Brix) by "liking" or "disliking" a given juice

Description	Brix-acid ratio											
	12		14		16		18		20		22	
	"Like"	"Dislike"	"Like"	"Dislike"	"Like"	"Dislike"	"Like"	"Dislike"	"Like"	"Dislike"	"Like"	"Dislike"
	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/	Pct. 1/
Just the right sweetness	66	28	74	34	72	30	82	44	84	37	75	38
Not sweet enough	7	10	5	8	6	6	7	10	3	6	4	3
Too sweet	4	6	4	6	5	12	3	10	3	20	9	19
Just the right tartness	66	27	66	28	69	23	78	45	73	31	68	29
Too tart or sour	21	52	18	42	18	46	7	27	8	28	11	24
Not tart or sour enough	2	6	4	9	5	14	5	7	6	21	8	20
Just the right body or consistency	70	47	73	43	79	39	82	36	83	37	68	40
Too thin or watery	22	41	17	47	13	50	10	43	12	55	26	49
Too thick	3	5	1	2	2	3	--	2	1	1	1	1
Does not taste like fresh orange juice, but still pretty good	51	33	50	35	53	25	50	38	48	34	53	27
Tastes like fresh orange juice	37	4	33	3	29	3	38	4	43	5	32	3
Tastes tinny	5	29	7	25	8	39	7	33	3	24	4	34
Tastes artificial	4	41	6	42	9	41	5	32	4	43	7	43
Number of people	248	198	256	211	260	202	261	201	256	217	266	221

1/ Percentages add to more than 100 because some respondents checked more than one descriptive item.

Table 13.--Preference ratings for six canned orange juices that vary in Brix-acid ratio (12° Brix) by respondents who had the same juice for both tests

Mean and standard deviation	Brix-acid ratio											
	12		14		16		18		20		22	
	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2	Test 1	Test 2
Mean -----------	7.00	6.68	7.45	7.46	7.50	7.78	6.87	6.61	6.86	6.83	6.90	7.20
Standard deviation ---------	2.22	2.75	2.31	2.39	2.09	2.24	2.87	2.87	2.05	2.13	2.67	2.30
t [1] -----------	1.37		0.14		1.51		2.12		0.31		1.14	
Number of people	35		46		42		45		42		49	

[1] Based on mean of individual differences for the two tests.

Table 14.--Proportions of Indianapolis homemakers using fresh, frozen concentrated, and canned orange juices within the last year

Use of product	Fresh orange juice	Frozen concentrated orange juice	Canned orange juice
	Percent	Percent	Percent
Used the product ----------	68	70	62
Did not use the product ---	32	30	38
Total -------------	100	100	100
Number of homemakers ------	695	695	695

Table 15.--Proportions of Indianapolis homemakers using fresh, frozen concentrated, and canned orange juice by family income

Use of product	Fresh orange juice			Frozen concentrated orange juice			Canned orange juice		
	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Used the product ------	63	67	71	58	74	83	65	63	57
Did not use the product	37	33	29	42	26	17	35	37	43
Total ----------	100	100	100	100	100	100	100	100	100
Number of homemakers --	195	189	192	195	189	192	195	189	192

Table 16.--Time of year when greatest use is made of fresh, frozen concentrated, and canned orange juice

Time of year when greatest use is made	Fresh orange juice	Frozen concentrated orange juice	Canned orange juice
	Percent	Percent	Percent
Winter months	29	8	8
Summer months	14	22	15
Same all year round	57	70	77
Total	100	100	100
Number of homemakers	466	483	427

Table 17.--Frequency of use of fresh, frozen concentrated, and canned orange juice during the time of year the greatest use is made of a given product

Frequency of use	Fresh orange juice	Frozen concentrated orange juice	Canned orange juice
	Percent	Percent	Percent
Several times a week	83	85	82
About once a week	10	6	7
Less than once a week	7	9	11
Total	100	100	100
Number of homemakers	469	484	430

Table 18.--Relation between yearly family income and frequency of use of fresh, frozen concentrated, and canned orange juice during the time of year when greatest use is made of a given product

Frequency of use	Fresh orange juice			Frozen concentrated orange juice			Canned orange juice		
	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)	Low income (less than $4,101)	Middle income ($4,101 to $6,413)	High income (over $6,413)
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Several times a week --	79	85	83	83	87	86	82	83	80
About once a week -----	12	7	12	10	6	4	10	4	5
Less than once a week -	9	8	5	7	7	10	8	13	15
Total ----------	100	100	100	100	100	100	100	100	100
Number of homemakers --	122	126	136	112	139	159	126	119	110

Table 19.--Reasons given for using fresh, frozen concentrated, and canned orange juice less than several times a week

Reasons given	Fresh orange juice	Frozen concentrated orange juice	Canned orange juice
	Percent [1/]	Percent [1/]	Percent [1/]
Food habit reasons; seldom think of it; use only for variety, etc.	47	48	55
Inconvenient; difficult to prepare	37	8	--
Cost; too expensive	10	20	1
Specific ailment prevents use	--	1	--
Too acid for health	2	1	1
Low in vitamin content	--	1	1
Miscellaneous health reasons	--	1	1
Dislike taste--unspecified	--	5	1
Too tart or sour	--	--	3
Too bitter	--	--	4
Too artificial	--	7	14
Too thin; too weak; watery	--	1	14
Tinny; metallic	--	1	12
Miscellaneous taste reasons	--	--	6
Miscellaneous other reasons	5	8	1
Number of homemakers	84	75	78

[1/] Percentages add to more than 100 because some homemakers gave more than one reason.

Table 20.--Reasons given for not using fresh, frozen concentrated, or canned orange juice within the last year

Reasons given	Fresh orange juice	Frozen concentrated orange juice	Canned orange juice
	Percent [1/]	Percent [1/]	Percent [1/]
Inconvenient; difficult to prepare; can't store; etc.	71	5	1
Food habit reasons; never think of it; etc.	18	52	24
Cost; too expensive	8	12	1
Never heard of product	--	5	--
Not, or seldom, available in stores	1	1	[2/]
Bad for health--unspecified	[2/]	2	4
Specific ailment prevents use	1	1	1
Causes indigestion	--	--	1
Too acid for health	[2/]	1	--
Low in vitamin content	--	1	3
Miscellaneous health reasons	1	1	2
Dislike--unspecified	1	4	3
Too artificial	--	4	19
Too thin; too watery; weak	[2/]	2	9
Tinny; metallic	--	1	23
Too bitter	--	1	13
Too sweet	[2/]	1	1
Too tart or sour	[2/]	1	5
Miscellaneous taste reasons	1	1	6
No freezing unit or refrigerator	--	2	--
Miscellaneous other reasons	8	7	5
Number of homemakers	225	209	264

[1/] Percentages add to more than 100 because some homemakers gave more than one reason.

[2/] Less than ½ of 1 percent.

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